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Movement is here intimately connected with the presence of free oxygen, which, if not present, can be produced by these organisms in the light.

2. *Paramœcium bursaria*. When the proportion of oxygen is normal, or somewhat greater than the normal amount, the infusorian is usually very quiet; if, however, it sinks ever so little below this degree, the animal becomes restless, and makes for places in which there is more oxygen (*e. g.*, edge of cover-glass); in good light, but under otherwise similar conditions, the specimens distribute themselves equally throughout the drop. Active swimming is the consequence of serious diminution of the oxygen; if strong light is then applied for some minutes, the *Paramœcium* courses rapidly about, and if insufficient supplies of oxygen are added from without, it shows itself very sensitive to alterations in the illumination in the spectrum; it prefers red of between the lines B. and C. High tension of oxygen reacts strongly on the movements, for the animals then tend to swim straight or in wide curves away from the point at which oxygen is present in abundance. Strong illumination applied suddenly at this time causes violent movements, and the *Paramœcium* often darts into the darkness, exhibiting the phenomenon of protophobia. Thus this animal is highly sensitive to differences in the tension of oxygen.

3. *Euglena viridis* is taken as the third type. Here the tension of oxygen has little to do with the movements. When the drop of water is partially illuminated the *Euglenæ* gradually assemble in the lighted area, and usually remain there; if a shadow is thrown upon the anterior chlorophyll-less portion of the body the animal turns and behaves as if wholly in darkness. This is not due to the eye-spot which is placed here, as the reaction is affected when the darkness first reaches the protoplasm outside it. This sensitiveness of the anterior end of the body is generally distributed amongst animals, and occurs in *Paramœcium bursaria*, in spite of the greater amount of chlorophyll contained in the posterior part. Engelmann has not as yet succeeded in finding blind or color-blind *Euglenæ*, but individuals from different localities and in different stages of development often show important variations in their sensitiveness to light.—*Journal Roy. Microscopical Society, Feb.*

PSYCHOLOGY.

ROMANES' ANIMAL INTELLIGENCE.¹—Our purpose in noticing this excellent book is rather expository than critical. We will first notice the introduction to the work, and in subsequent paragraphs give the author's statements as to our present knowledge of the mental endowments of the different groups of animals in

¹Animal Intelligence. By George J. Romanes. International Scientific Series. New York, D. Appleton & Co., 1883, 12mo, pp. 520.

the ascending order, as it is undoubtedly the freshest and, in most respects, best work of the sort at our command. Mr. Romanes, in the present volume, brings together the leading facts bearing on the instincts and reasoning powers of animals; in a second volume he proposes to consider the facts of animal intelligence in their relation to the theory of descent; in other words to the evolution of mind in animals and man.

The present volume is largely made up of anecdotes about animals, and as such will find many readers, as the subject is one of much popular interest. Many of the anecdotes are, however, fresh and pertinent, and while the author has, so far as possible, endeavored to suppress anecdotes, he has found it of course impossible not to give most of his space to them. He has been fortunate in having had placed at his command, by Mr. Darwin, shortly before his death, "all the notes and clippings on animal intelligence which he has been collecting for the last forty years, together with the original MS. of his wonderful chapter on 'Instinct.'" "This chapter," adds Mr. Romanes, "on being recast for the 'Origin of Species,' underwent so merciless an amount of compression, that the original draft constitutes a rich store of hitherto unpublished material." In his second work he proposes to draw upon this store more largely than in the present one.

In the introduction Mr. Romanes lays down the general principles upon which he constructs his work. His criterion of mind is as follows: "Does the organism learn to make new adjustments, or to modify old ones, in accordance with the results of its own individual experience? If it does so, the fact cannot be due merely to reflex action in the sense above described, for it is impossible that heredity can have provided in advance for innovations upon, or alterations of, its machinery during the life time of a particular individual."

Rejecting the theory of animal automatism on the ground that it can never be accepted by common sense, he claims that as a philosophical speculation "by no feat of logic is it possible to make the theory apply to animals to the exclusion of man." He insists that the mind of animals must be placed in the same category as the mind of man. The proof is the fact that an animal is able to learn by its own individual experience. "Wherever we find an animal able to do this, we have the same right to predicate mind as existing in such an animal that we have to predicate it as existing in any human being other than ourselves."

The author then attempts to draw the line between reflex and instinctive action. This line, he thinks, "is constituted by the boundary of non-mental or unconscious adjustment, with adjustment, in which there is concerned consciousness or mind."

Finally Mr. Romanes thus defines reflex action, instinct and reason:

"Reflex action is non-mental neuro-muscular adjustment, due

to the inherited mechanism of the nervous system, which is formed to respond to particular and often recurring stimuli, by giving rise to particular movements of an adaptive though not of an intentional kind.

"Instinct is reflex action into which there is imported the element of consciousness. The term is therefore a generic one, comprising all those faculties of mind which are concerned in conscious and adaptive action, antecedent to individual experience, without necessary knowledge of the relation between means employed and ends attained, but similarly performed under similar and frequently recurring circumstances by all the individuals of the same species.

"Reason or intelligence is the faculty which is concerned in the intentional adaptation of means to ends. It therefore implies the conscious knowledge of the relation between means employed and ends attained, and may be exercised in adaptation to circumstances novel alike to the experience of the individual and to that of the species."

These definitions, are, it seems to us, an improvement, in most respects, on any which have yet been made, though in that of instinct the idea that instinct is the sum of inherited, originally conscious habits, might have been more distinctly emphasized. J. J. Murphy's definition, to which Romanes does not refer, that "instinct is the sum of inherited habits," is neat and terse. The facts recorded in the different chapters are arranged not under reflex, instinctive and rational actions, as we should have expected, but roughly under the general heads of general intelligence, memory, &c. Chapters are devoted to ants, bees, wasps, the dog, cat and monkey.

Of course any one can supply a number of published anecdotes and statements which the author has omitted; perhaps from lack of acquaintance with the literature, so scattered and often inaccessible. While speaking of the architectural habits of the hive bee, one wonders that the author had not acquainted himself with the late Professor Wyman's remarkable paper on the cells of the honey bee, as well as Reaumur and Maraldi's observations, but these, perhaps, were beside his purpose. Mr. Dall's article in this journal (Dec., 1882) on the intelligence in a snail and its power of recognizing a call or sound, and of distinguishing it from other sounds, was overlooked. As regards the intelligence of crabs, the case of "homing" instinct noticed by an English observer, would have been in place. A number of typographical errors somewhat mar the book.

On the whole, the work is an excellent contribution to the subject, though we must confess to a shade of disappointment felt here and there as to the method of treatment, as from the author's other writings we had expected something a grain better. He has, moreover, failed to notice some authors who have antici-

pated his views on various points. We shall look with interest for the second work on "Mental Evolution," which demands powers of high order for its successful treatment.

INTELLIGENCE IN PROTOZOA.—Romanes in his "Animal Intelligence" says, "No one can have watched the movements of certain Infusoria without feeling it difficult to believe that these little animals are not actuated by some amount of intelligence." He then describes the means taken by a large rotifer to shake off a smaller individual which had fastened itself by its forceps to the former. He claims that the beginnings of instinct are to be found so low down in the scale as the Rhizopoda. He quotes from Mr. H. J. Carter, who says: "Even *Athealum* will confine itself to the water of the watch-glass, in which it may be placed, when away from sawdust and chips of wood among which it has been living; but if the watch-glass be placed upon the sawdust, it will very soon make its way over the side of the watch-glass and get to it."

He then cites the actions of the *Actinophrys* in getting its food, and of *Amœba* in seizing its prey, young *Acinetæ*, but concludes that we should not "be justified in ascribing to these lowest members of the zoölogical stage any rudiment of truly mental action.

ANTHROPOLOGY.¹

THE CARSON FOOTPRINTS.—In the area of an excavation made for the foundation of the penitentiary at Carson, Nevada, are impressions in the sandstone that are probably footprints. The most remarkable among these is a series which have been supposed to be the tracks of giant human beings, the ancestors of the present human race. Dr. Walter J. Hoffman visited the site last fall in the interest of the Bureau of Ethnology, and brought to Washington a cast of one of the depressions. Dr. Hoffman's conclusions, in a communication to the *New York Weekly Herald* (Nov. 18), are as follows: "The only animal capable of producing impressions any way similar to these are the bear and the *Mylodon*, or gigantic ground sloth. They are neither of these, and the theory gaining most followers is that 'it is the missing link in the chain of human evolution.'" A note in the last number of *Revue d'Anthropologie de Paris* rehearses Dr. Hoffman's researches, and expatiates on the evidence of the existence of Tertiary man. Mr. G. K. Gilbert, of the U. S. Geological Survey, has received from Mr. Russel a skilled observer on the spot, some valuable information upon these footprints, which he communicated to the Washington Anthropological Society. Mr. Russel confirms Prof. Cope's determination that the beds are Upper Pliocene or Lower Quat-

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